

[54] **NON-DESTRUCTIVE OPTICAL TRAP FOR BIOLOGICAL PARTICLES AND METHOD OF DOING SAME**

[75] Inventors: Arthur Ashkin, Rumson; Joseph M. Dziedzic, Clark, both of N.J.

[73] Assignees: American Telephone and Telegraph Company, New York, N.Y.; AT&T Bell Laboratories, Murray Hill, N.J.

[21] Appl. No.: 98,120

[22] Filed: Sep. 17, 1987

[51] Int. Cl.⁴ G02B 27/00

[52] U.S. Cl. 350/1.1

[58] Field of Search 350/1.1

[56] References Cited

U.S. PATENT DOCUMENTS

3,710,279	1/1973	Ashkin	331/94.5
3,808,432	4/1974	Ashkin	250/251
3,808,550	4/1974	Ashkin	331/94.5
4,327,288	4/1982	Ashkin et al.	250/251

OTHER PUBLICATIONS

Physical Review Letters, vol. 24, No. 4, Jan. 26, 1970, "Acceleration and Trapping of Particles by Radiation Pressure", by A. Ashkin, pp. 156-159.

Appl. Phys. Lett., vol. 19, No. 8, Oct. 15, 1971, "Optical Levitation by Radiation Pressure", by A. Ashkin et al., pp. 283-285.

Physical Review Letters, vol. 40, No. 12, Mar. 20, 1978, "Trapping of Atoms by Resonance Radiation Pressure", by A. Ashkin, pp. 729-732.

Science, vol. 210, No. 5, Dec. 5, 1980, "Applications of

Laser Radiation Pressure", by A. Ashkin, pp. 1081-1088.

Physical Review Letters, vol. 57, No. 3, Jul. 21, 1986, "Experimental Observation of Optically Trapped Atoms", by Chu et al., pp. 314-317.

Physical Review Letters, vol. 41, No. 20, Nov. 13, 1978, "Observation of Focusing of Neutral Atoms by the Dipole Forces of Resonance-Radiation Pressure", by Bjorkholm et al., pp. 1361-1364.

Applied Optics, vol. 19, No. 5, Mar. 1, 1980, "Observation of Light Scattering from Nonspherical Particles Using Optical Levitation", by A. Ashkin et al., pp. 660-668.

Optics Letters, vol. 8, No. 10, Oct. 1983, "Stability of Radiation-Pressure Particle Traps: an Optical Earnshaw Theorem", by A. Ashkin et al., pp. 511-513.

Physical Review Letters, vol. 54, No. 12, Mar. 25, 1985, "Observation of Radiation-Pressure Trapping of Particles by Alternating Light Beams", by A. Ashkin et al., pp. 1245-1248.

Optics Letters, vol. 11, No. 5, May 1986, "Observation of a single-beam Gradient Force Optical Trap for Dielectric Particles", A. Ashkin et al., pp. 288-290.

Primary Examiner—Bruce Y. Arnold

Attorney, Agent, or Firm—Gregory C. Ranieri

[57]

ABSTRACT

Biological particles are successfully trapped in a single-beam gradient force trap using an infrared laser. The high numerical aperture lens objective in the trap is also used for simultaneous viewing.

Several modes of trapping operation are presented.

5 Claims, 3 Drawing Sheets

